



# Southern Pine Beetle Outbreaks Associated with Climate Change in Honduras

by

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## Abstract

Pine forests, consisting primarily of *Pinus oocarpa* and *P. caribaea*, cover some 2.5 million hectares and are one of the principal natural resources in Honduras. Historically, these forests have been subjected to ecological impacts and economic losses caused principally by wildfires and outbreaks of the southern pine beetle (SPB), *Dendroctonus frontalis* (Coleoptera: Curculionidae: Scolytinae). To explore the relationship between SPB outbreaks and environmental conditions in Honduras, we developed a model relating periodic SPB outbreaks to climatic variables and occurrence of wildfires. We found that increases in mean ambient temperatures in the month of June, reductions in mean monthly precipitation in June and July, and climatic anomalies in warm months that influence the annual frequency of wildfires were positively correlated with the occurrence and extent of southern pine beetle outbreaks since 1982. The linear model was used to predict future trends in SPB activity in Honduras as a function of expected changes in climate. Results suggest that SPB outbreaks in Honduras and other Central American countries are likely to become more frequent and severe as the climate changes.

## Methods

We developed two linear models that correlated the frequency and extent of wildfires and SPB outbreaks from 1982 to 2006 with climatic data. Records of the frequency and severity of SPB outbreaks and wildfires were obtained from the Honduran Forestry Development Corporation (Corporación Hondureña de Desarrollo Forestal) for the period 1982-2006. The Honduran Secretary of Natural Resources and Environment (Secretaría de Recursos Naturales y Ambiente de Honduras or SERNA) provided historical weather data (rainfall and mean temperatures). Climatic scenarios for the period 2011 – 2025 were obtained from the PRECIS-CARIBE program of the Meteorological Institute of Cuba.

## Results

The frequency and severity of wildfires and SPB outbreaks were evaluated with respect to various climatic variables, including average temperature and rainfall annually and by wet and dry season, occurrence of climatic events such as El Niño y La Niña, number of dry, wet or warm months, area under forest management, and area burned by wildfires. For wildfires, the model we developed is:

$$A_i = 12,600 + 10,900 \text{ NMAO}_{1.75} + 10,400 \text{ NMA1}_{1.75} + 5,120 \text{ NMA1}_x$$

( $R^2=0.84$ ,  $p<0.001$ )

where  $A_i$  = hectares burned;  $\text{NMAO}_x$  = number of above-average warm months during the current year, and  $\text{NMA1}_x$  = number of above-average warm months during the previous year (Fig. 1).



For *D. frontalis*, we developed the following model correlating outbreaks with climatic factors (Fig. 2):

$$AA = 185,030 + 0.140 A_i + 3,590 T_1 - 35.8 P_1$$

( $R^2=0.46$ ,  $p < 0.01$ )

where AA = area affected (ha) by *D. frontalis* in a given year,  $A_i$  is area (ha) burned,  $T_1$  = mean June temperature,  $P_1$  = mean precipitation for June + July.

SPB outbreaks in Honduras were positively correlated with warmer than average temperatures in June and negatively correlated with mean precipitation in June and July. This model was used to project the severity of *D. frontalis* outbreaks in Honduras from 2010 to 2025. Results (Fig. 2) suggest an increasing severity of outbreaks associated with a climate that is predicted to change in the next 15 years. Average annual area affected by SPB from 2010 - 2025 is estimated to be 6,500 hectares per year, higher than during the period 1982-2000 (2,000 ha) and between 2000 – 2006 (6,000 ha).

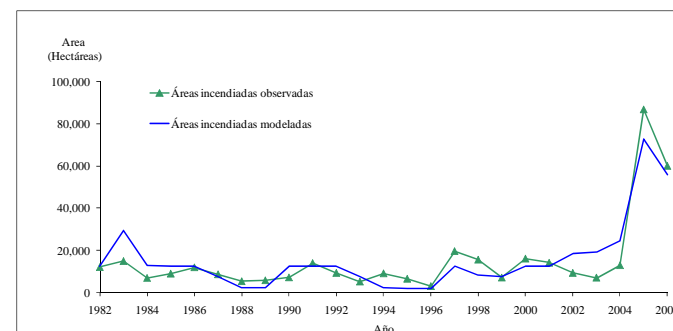


Figure 1. Predicted and observed area burned by wildfires in Honduras.

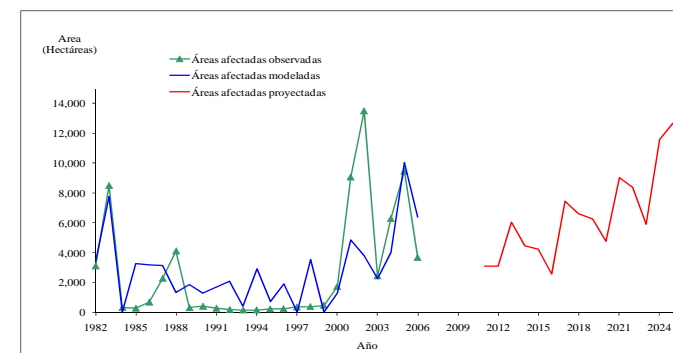


Figure 2: Predicted, observed, and projected area affected by *D. frontalis* outbreaks in Honduras: 1982 – 2025.

## Conclusions and Management Recommendations

Our model suggests that SPB outbreaks are likely to become more severe in the future than in recent decades in Honduras if predicted climate changes occur. Resource losses can be reduced by prompt detection and control of infestations (as practiced in Honduras during the period 1989–2000). Prevention programs that identify and manage beetle-prone landscapes and specific pine stands are needed. By thinning pine stands periodically, controlling active SPB infestations, and preventing or rapidly controlling wildfires, forest managers should be able to substantially limit resource losses (Billings et al. 2004).

## Literature Cited

Billings, R.F. and others. 2004. Bark beetle outbreaks and fire: A devastating combination for Central America's pine forests. UNASYLVA 55: 15-21.